

↙ SN 10/596,181

PTO 09-4325

CC=JP DATE=19940405  
KIND=A PN=06090950

ULTRASONIC PROBE [CHOONPA TANYUSHI]

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APRIL 2009 TRANSLATED BY: SCHREIBER TRANSLATION, INC.

PUBLICATION COUNTRY (10): JP DOCUMENT NUMBER (11): 06090950

DOCUMENT KIND (12): A PUBLICATION DATE (43): 19940405

APPLICATION NUMBER (21): 4267799 APPLICATION DATE (22):

19920911 INTERNATIONAL CLASSIFICATION (51): A 61 B 8/00 ; G 01

N

SN 10/596,181

29/24 ; H 04 R 17/00

PRIORITY COUNTRY (33):

PRIORITY NUMBER (31):

PRIORITY DATE (32):

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DESIGNATED CONTRACTING STATES (81): TITLE (54): ULTRASONIC

PROBE FOREIGN TITLE [54A]: CHOONPA TANYUSHI [Claim] [Claim 1]

An ultrasonic probe characterized as arraying a plurality of narrow bar-shaped piezo-electric oscillators on a packing material and at the same time laminating an acoustic aligning layer and a thin bar-shaped acoustic lens on the abovementioned piezo-electric oscillator, the invention characterized as increasing the acoustic impedance in a direction which is orthogonal to the arraying direction of the piezo-electric oscillator between the abovementioned piezo-electric oscillator group and the packing material so that the acoustic impedance lessens as the center part advances toward the end part.

[Detailed Description of Invention]

[0001]

[Industrial Field]

The present invention relates to an acoustic wave probe used for an ultrasonic diagnostic device and particularly to a technique for improving the directivity of ultrasonic waves in the direction which is orthogonal to the arraying direction of the oscillator in an electron scanning type ultrasonic probe made by arraying a large number of bar-shaped piezo-electric oscillators in an array formation.

[0002] [Prior  
Art]

As is well known from the literature, electronic scanning type ultrasonic probes are made by disposing a narrow bar-shaped piezo-electric oscillator in an array shaped on a noise-absorption material (also known as a packing material), which sets in place a plurality of acoustic alignment layers on the top surface of a piezo-electric oscillator and the top of the acoustic alignment layer is covered with an acoustic lens.

[0003]

Of the abovementioned constituent features, the purpose of the acoustic lens is to focus the ultrasonic wave in the direction which is orthogonal to the arraying direction of the piezo-electric oscillator (hereinafter, "minor axis

direction"). Thus, it is shaped so that the center part of the horizontal cross section is a thin bar since the ultrasonic wave focusing in the minor axis direction uses the transmission speed of the ultrasonic waves using the acoustic lens and the probe can be easily made to adhere to the surface of the subject. Thanks to this shape, ultrasonic waves from the end part of the narrow bar-shaped piezo-electric oscillator are transmitted to the subject rapidly and ultrasonic waves from the center part are transmitted inside the subject slowly so that the ultrasonic wave beams are focused in the minor axis direction.

[0004]

[Problems Which the Present Invention is Intended to Solve]

When the abovementioned conventional technique was used, the ultrasonic wave beams were focused in the minor axis direction. However, on the other hand, the sound pressure distribution in the minor axis direction in the subject conversely made the acoustic lens concave rather than convex due to the attenuation caused by the thickness of the acoustic lens. These results can hardly be termed suitable on the surface of the beam directivity.

[0005]

Taking note of the above, it is an object of the present invention to provide an ultrasonic wave probe which improves the noise pressure distribution in the minor axis reaction by closely adhering to the subject without changing the shape of the conventional convex acoustic lens thereby improving the directivity of the ultrasonic wave beams making it possible to obtain a good ultrasonic wave image.

[0006]

[Means Used to Solve the Problems]

The present invention attains the abovementioned objectives so that it is an ultrasonic probe made by arraying a large number of narrow bar-shaped piezo-electric oscillators on a packing material and by laminating an acoustic aligning layer and a thin [illegible] acoustic lens on the top surface of the abovementioned piezoelectric oscillator group, the invention characterized as setting in place a thin film material which increases the acoustic impedance between the abovementioned piezoelectric oscillator group and packing material wherein the center part reduces the acoustic impedance as it advances toward the end part in the direction

which is orthogonal to the arraying direction of the piezo-electric oscillator group.

[0007]

[Actions]

When the packing material and the abovementioned thin film material and piezo-electric oscillator are laminated, as the effective impedance of the packing material seen from the piezo-electric oscillator advances from the center part of the minor axis direction, it becomes larger. As a result, the oscillation efficiency of the bar-shaped piezoelectric oscillator is high at the center part and declines as it advances toward the end part. As a result, the convex shape in the center part of the noise pressure distribution is [illegible] since the acoustic lens becomes convex in the center part.

[0008]

[Practical Embodiment of Invention]

Next, we shall explain a practical example of the present invention using Figure 1. Figure 1 is a partial, sectional view used to explain the inside configuration of the electron scanning type ultrasonic probe. In Figure 1, 1 is made up of PZT and is an oscillator part made by arraying in an array shape a large number of piezo-electric oscillators 11 having

an acoustic impedance of  $20 \times 10^0 \text{ kg/m}^2 \cdot \text{sec}$ . 3 absorbs and attenuates the ultrasonic waves radiated to the back surface of the oscillator when piezoelectric oscillator 11 using a packing material. As a result, a material such as ferrite rubber having an acoustic impedance of  $Z_6 = 7.6 \times 10^0 \text{ kg/m}^2 \cdot \text{sec}$  may be used. 4 has a film thickness of  $\lambda/4$  when the wavelength is  $\lambda$  on the acoustic aligning layer, is [illegible] laminated and the ultrasonic waves can readily enter the body of the subject. 5 is an acoustic lens discussed previously. The abovementioned configuration is the same as that of the conventional probe.

[0009]

Next, we shall explain the characteristic points of the present invention. In Figure 1, 2 is a thin film material having a composite configuration made up of three types of materials and the effective impedance of the packing material seen from the piezo-electric oscillator in accordance with the position relative to the minor axis direction. Thin film material 2 has a thickness of  $\lambda/4$  and is made up of a polyurethane resin part 21 positioned in the center part in the minor axis direction, epoxy resin part 22 positioned so that it is adjacent to both of these and ferrite rubber part 23 positioned on both end parts. The acoustic impedance of these acoustic impedance example,

$Z_{11}, Z_{12}, Z_{21}, Z_{22}$  is  $Z_{11} < Z_{12} < Z_{21}$  for

where  $Z_{11} = 2.2 \times 10^6 \text{ kg/m}^2 \cdot \text{sec}$ ,  $Z_{12} = 3.3 \times 10^6 \text{ kg/m}^2 \cdot \text{sec}$ ,  $Z_{21} = 7.5 \times 10^6 \text{ kg/m}^2 \cdot \text{sec}$  and

[0010]

In this case, the effective impedance of the packing material seen from piezo-electric oscillator 11 is expressed as

$$(Z_{11})' / Z_0 = 0.6 \times 10^6 \text{ kg/m}^2 \cdot \text{sec} \quad (Z_{11})' = 1.5 \times 10^6 \text{ kg/m}^2 \cdot \text{sec}, \quad (Z_{21})' = 7.5 \times 10^6 \text{ kg/m}^2 \cdot \text{sec}$$

$$(Z_{21})' = 7.5 \times 10^6 \text{ kg/m}^2 \cdot \text{sec} \quad \text{on the respective}$$

parts. As a result, the oscillation effect of the piezo-electric oscillator on each of the parts is  $20 / (20 + 0.6) =$

$0.97 = 97\%$  in the middle part;  $20 / (20 + 1.5) = 0.93 = 93\%$  on

the part which adjoins the center part; and  $20 / (20 + 7.5) =$

$0.727 = 72.7\%$  on both end parts.

[0011]

As a result, when a single narrow bar-shaped piezo-electric oscillator is oscillated, the noise pressure distribution is high in the center part and declines as it



advances to the end part. As a result, the noise pressure distribution of the ultrasonic waves which enter the subject from acoustic lens 5 can become convex rather than the conventional concave shape. In other words, the ultrasonic wave beams narrow in the minor axis direction which is equivalent to the directivity having been improved.

[0012]

The present invention is by no means restricted to the practical embodiment given above and it can be modified as long as it does not depart from the gist of the invention. For example, in the practical embodiment indicated above, a composite member made of three different types of acoustic impedance member was used as the thin film material used to change the noise pressure distribution. However, it may be made of four or more types of member to make the noise pressure distribution smoother.

[0013]

[Effect of Invention]

The present invention as indicated above can improve the directivity of ultrasonic beams in the minor axis direction by setting in place a thin film material whose acoustic impedance changes in the minor axis reaction between the oscillator and the packing material, so that the noise pressure distribution

of the ultrasonic waves from the probe in the minor axis direction is changed from the conventional concave shape to a convex shape, thereby improving the directivity of the ultrasonic wave beams in the minor axis direction. As a result, the ultrasonic wave image consists of thin slices showing the subject and the picture quality is improved. In addition, the side lobes are reduced as a collateral effect and the S/N can be improved.

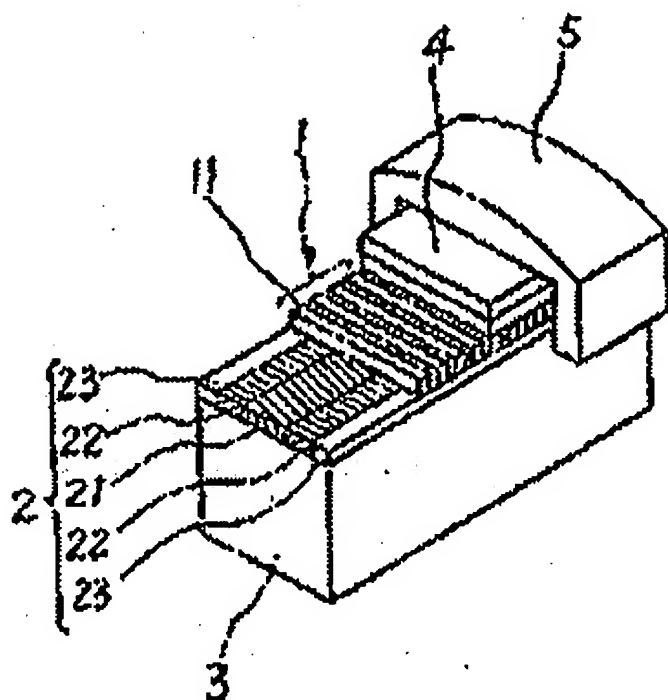
[Brief Explanation of Figure]

[Figure 1]

A partial sectional inclined view of the inside structure of the ultrasonic wave probe in the practical embodiment of the present invention.

[Explanation of Notation] 1..oscillator part 2..thin film material 3..packing material 4..acoustic alignment layer 5..acoustic lens

【図 1】



[Figure 1]